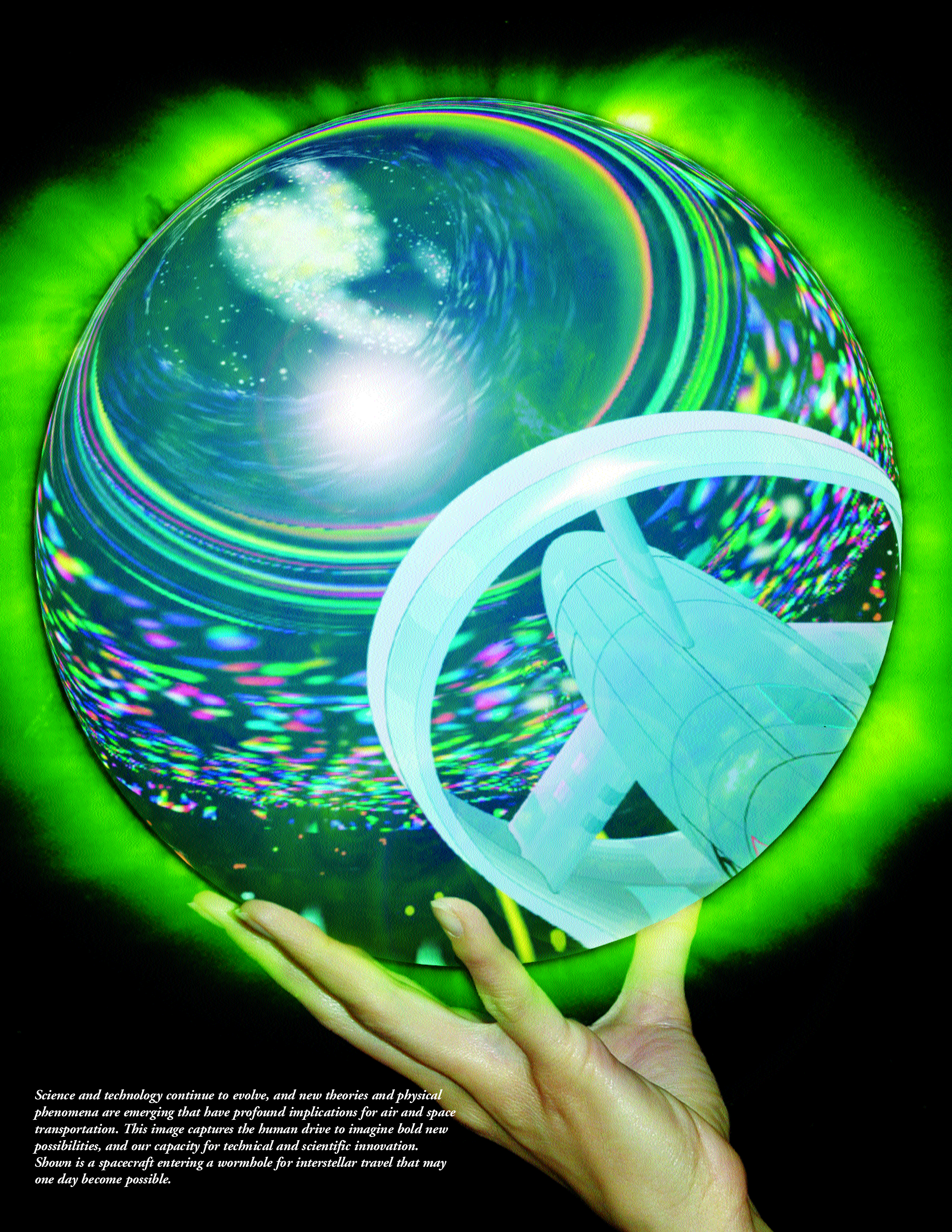


Science and technology continue to evolve, and new theories and physical phenomena are emerging that have profound implications for air and space transportation. This image captures the human drive to imagine bold new possibilities, and our capacity for technical and scientific innovation. Shown is a spacecraft entering a wormhole for interstellar travel that may one day become possible.

Goal Three: Pioneer Technology Innovation

NASA's goal is to enable a revolution in aerospace systems.

In order to develop the aerospace systems of the future, revolutionary approaches to system design and technology development will be necessary. Pursuing technology fields that are in their infancy today, developing the knowledge bases necessary to design radically new aerospace systems, and performing efficient, high-confidence design and development of revolutionary vehicles are challenges that face us in innovation. These challenges are intensified by the demand for safety in our highly complex aerospace systems. The goal to Pioneer Technology Innovation is unique in that it focuses on broad, crosscutting innovations critical to a number of NASA missions and to the aerospace industry in general.

Objective 9: Engineering Innovation
Develop advanced engineering tools, processes, and culture to enable rapid, high-confidence, and cost-efficient design of revolutionary systems.

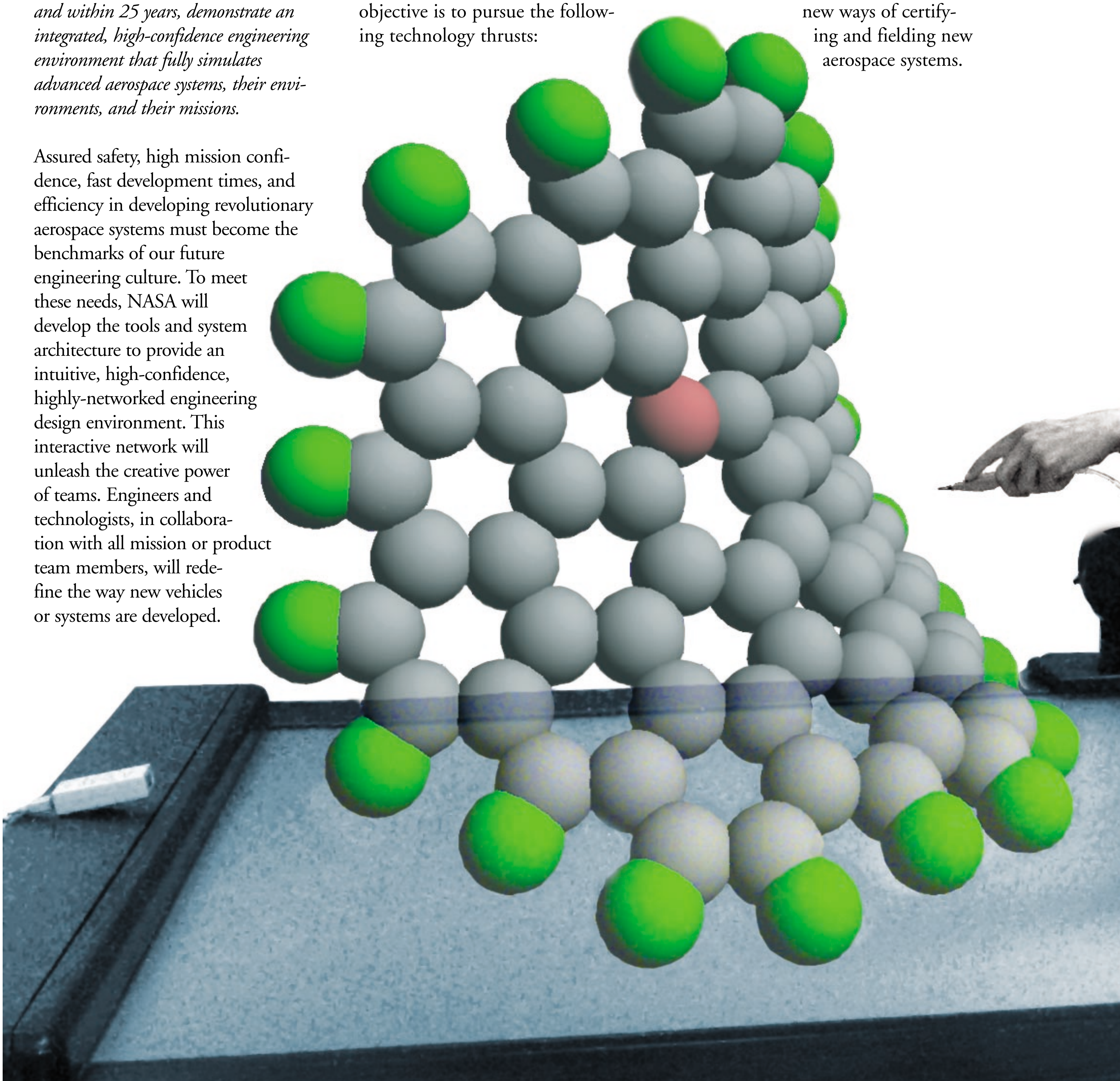
Within 10 years, demonstrate advanced, full-life-cycle design and simulation tools, processes, and virtual environments in critical NASA engineering applications; and within 25 years, demonstrate an integrated, high-confidence engineering environment that fully simulates advanced aerospace systems, their environments, and their missions.

Assured safety, high mission confidence, fast development times, and efficiency in developing revolutionary aerospace systems must become the benchmarks of our future engineering culture. To meet these needs, NASA will develop the tools and system architecture to provide an intuitive, high-confidence, highly-networked engineering design environment. This interactive network will unleash the creative power of teams. Engineers and technologists, in collaboration with all mission or product team members, will redefine the way new vehicles or systems are developed.

Designing from atoms into aerospace vehicles, engineering teams will have the ability to accurately understand all key aspects of its systems, its operating environment, and its mission before committing to a single piece of hardware or software.

NASA's strategy for achieving this objective is to pursue the following technology thrusts:

- **Process and Concept Innovation**—Develop new processes and concepts for accomplishing full-life-cycle ("cradle-to-grave") planning and design of new, revolutionary aerospace systems.
- **Validation and Implementation**—Develop technologies and concepts for new ways of certifying and fielding new aerospace systems.



Objective 9: Engineering Innovation

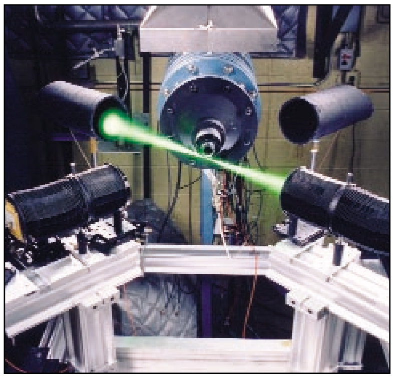
- **Information Technologies**—Develop computational capabilities and knowledge bases necessary to design new aerospace systems.
- **Advanced Engineering and Analysis Technologies**—Develop design tools and the ability to model any part of a new vehicle design during any part of the system's span and under all operating conditions and environments.

The metric related to these thrusts is the design confidence of advanced aerospace systems.

Outcomes

A successful effort would have the following outcomes:

- Ability to fully and accurately synthesize all aspects of an advanced aerospace system design in a virtual environment, with a full understanding of its capabilities and its safety and mission risk in its operational environment.
- High confidence in all key design parameters, such as safety, performance, and cost, throughout the design process.
- A fully collaborative engineering environment across all disciplines.



A complex new argon-ion laser measurement technique allows scientists to "see" sound. With this tool, researchers can very accurately measure turbulence parameters that will help them understand the physics of how a supersonic jet flow creates sound, enabling more efficient aerodynamic design.

Key Strategy and Partnership Issues

To ensure continuous progress, a steady investment in prioritized basic research is required, coupled with focused efforts to integrate and apply the new technologies and processes. NASA will use both small and large-scale mission applications and advanced concepts to validate integrated engineering environments, processes, and tool sets. NASA will partner with other government agencies, industry, consortia, and academia to bring about the needed innovations. Key partnerships include DoD, with their initiatives related to design and manufacturing, the National Science Foundation (NSF), the Department of Energy (DoE), and the National Institute of Standards and Technology (NIST).

The NASA Education and Research Network project is providing gigabit networking technology to demonstrate a 3-D simulator that allows users to see, move, and even feel simulated molecular structures. Christopher Henze, of Ames Research Center, uses a tool to manipulate a graphite molecular model with the Virtual MechanoSynthesis (VMS) 3-D simulator. VMS is an important tool to help scientists better understand how to design nano-electronic components, chemical- and bio-sensors, and nano-tubes. Gigabit networking, a means to deliver huge volumes of data to multiple distant users simultaneously, is important to VMS's viability.

Objective 10: Technology Innovation
Develop revolutionary technologies and technology solutions to enable fundamentally new aerospace system capabilities and missions.

Within 10 years, integrate revolutionary technologies to explore fundamentally new aerospace system capabilities and missions; and within 25 years, demonstrate new aerospace capabilities and new mission concepts in flight.

Scientists and engineers will need cutting edge technologies to accelerate progress and change the definition of what is possible in aerospace. NASA will aggressively explore fields with a high potential for creating advanced performance characteristics in structures and systems, such as information technology, biologically-inspired technology, and nanotechnology. The ability to build air and space vehicle structures and devices in new ways, perhaps atom by atom, can enable greater strength and functionality at a lower mass. New capabilities, such as self-repair of surfaces or components, automatic shape changes for optimal performance, autonomous systems, and cooperative inter-vehicle behavior, can enable safer, more reliable vehicles and systems.

NASA's strategy for achieving this objective is to pursue the following technology thrusts:

- **Core Competencies**—Build and advance, within NASA the technology competencies that have potential for major benefits to aerospace applications.
- **Enabling New Missions**—Develop technologies for missions that are currently unrealistic, from personal air transportation to interstellar travel. This thrust will remove barriers such as high technology costs, limits to human endurance, and immense mission timeframes, to open exciting new possibilities.

Wings of fabric can be a commercial reality, due to extremely innovative and cost-effective techniques for stitching dry textile fabric preforms, then curing them with a resin film infusion. This composite technology developed at Langley Research Center offers the potential to greatly reduce airframe production and operation costs by increasing efficiency (eliminating the need for thousands of metal fasteners) and reducing weight.

Objective 10: Technology Innovation

• **Enabling New Capabilities**—Develop capabilities that are not possible today, such as autonomy sufficient to conduct an entire mission without human intervention, or self-repair of a vehicle's skin.

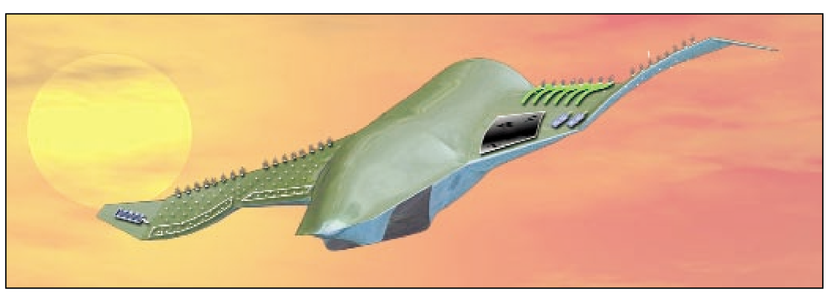
Outcomes

A successful effort would have the following outcomes:

- Revolutionary levels of performance for aerospace systems, with extraordinary reductions in vehicle mass and increases in efficiency.
- Aerospace systems that will have greater capability for a given function, new functionality not possible today, and the ability to perform complex, safety-critical missions without human intervention.

Key Strategy and Partnership Issues

Consistent, sustained investment in basic research tied to advancing aerospace concepts and functionality is essential in fostering innovation in aerospace technology. NASA will develop applications, from the laboratory through flight, to integrate and demonstrate innovative technologies and revolutionary concepts. NASA will also make a sustained effort in modeling, to explore revolutionary concepts for both aviation and advanced space exploration systems, not only of vehicles but of entire transportation system architectures as well. To support this objective, NASA will augment its traditional technology competencies as well as build promising new competencies in information technology, biologically-inspired technology, and nanotechnology. NASA is planning strategic partnerships with the other NASA Enterprises, industry, academia, and with other government agencies such as DoD, DoE, the National Oceanic and Atmospheric Administration (NOAA), and the National Reconnaissance Office (NRO), to take advantage of complementary mission needs and technology expertise.



This graphic is a vision of an advanced vehicle concept that employs technologies such as embedded, distributed computing and sensors for vehicle control; active shape control for flight optimization; high-strength carbon nano-tube composite structures; distributed vectored propulsion systems; and self-healing, multi-function materials.